SCOPE OF THE REPORT

This is the first State-of-the-Watershed Report for the Clear Creek watershed. It provides a snapshot of major water quality and water quantity resources of the basin. Future reports will expand the water resource reporting, as well as include information on open space, parks, trails, habitat, wildlife and other related resources.

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State of the Watershed

REPORT - 1997

Clear Creek, Colorado

TABLES

MAPS

I. OVERVIEW OF THE CLEAR CREEK WATERSHED

Clear Creek's headwaters begin amidst the 14,000 foot peaks of Colorado along the Continental Divide near the Loveland Ski Area. Between the mountains and the plains, it flows through a handful of mountain communities and a majestic, undeveloped canyon in the foothills. It then becomes an urban stream providing scenery, trails, and habitat for wildlife as it flows through the north Denver metropolitan area on its way to join the South Platte River. Clear Creek is noted for its scenic grandeur, a rich mining heritage, limited-stakes gaming, and whitewater recreation. It is also an important source of water for a variety of uses such as agriculture, drinking water, and industry. Clear Creek is a stream with major water quality problems related to metals and concerns related to nutrients. The water quality problems are derived from natural sources, historic mining, municipal and industrial uses, and land use practices.

WATERSHED: *A watershed consists of two elements: a water body and the adjacent land from which water drains into that water body. In terms of water quality, the stream and the land are inseparable; water draining off the land carries with it the effects of nature and human activities.*

The Clear Creek watershed is often characterized as the upper basin and the lower basin. The upper basin consists of mountainous and foothills areas and encompasses two-thirds of the watershed. The lower basin is urbanized. Standley Lake is an important element of the Clear Creek watershed although it is located outside of the watershed. Water from Clear Creek is diverted into Standley Lake which supplies drinking water to several communities in the north Denver metropolitan area.

Communities

The counties and communities of the watershed are shown on Map 1, contained in Chapter X of this report. They include five counties and a dozen towns and cities. They range from picturesque mountain towns like Georgetown to gaming boom towns like Black Hawk and Central City to Golden, home of the Colorado School of Mines, to growing suburban areas like Arvada and Wheat Ridge. The Standley Lake cities, which tap Clear Creek water primarily for out-of-basin use, include Northglenn, Thornton, and Westminster. The largest land manager in the watershed is the U.S. Department of Agriculture (USDA) Forest Service. Fully one-third of the basin lies within the Arapaho-Roosevelt National Forest and is administered by the Clear Creek Ranger District. Other public lands are managed by the U.S. Department of the Interior Bureau of Land Management (BLM) and the State of Colorado Land Board. In 1995 the BLM lands in Clear Creek County were turned over to the county for disposition.

The Clear Creek Watershed Story

Watershed

The Clear Creek watershed community has been described as a "culture of cooperation." It wasn't always that way. As recently as 1987, relationships between local community and business interests and the governmental agencies were strongly adversarial. Local interests felt that the state and federal regulatory presence was heavy-handed and they reacted angrily. This marked the low ebb of these relationships.

The turnaround in the relationship started with an honest attempt to listen and learn about each other's values - first, on the part of the regulatory community, such as the U.S. Environmental Protection Agency (EPA) and the Colorado Department of Public Health and Environment (CDPHE), and second, on the part of local people. Regulators learned to appreciate local values and wisdom—the special relationship with and knowledge of the land, the importance of personal relationships, and the unique rhythm and heritage of each community. At the same time, local people learned to appreciate what regulators could contribute: the technical knowledge and resources to address highly complex water quality issues.

Subsequently, through organizations like the Clear Creek Watershed Forum, the Upper Clear Creek Watershed Association, and the Upper Clear Creek Wathershed Advisory Group, relationships have been strengthened and a workable watershed effort has evolved. The groups bring together diverse watershed interests and create an atmosphere of cooperation.

The Clear Creek Watershed Forum is an informal organization which transcends the boundaries of any one agency, community, industry, or organization within the watershed. The role of the Forum is to bring people together from throughout the watershed to share information and to develop cooperative water quality improvement strategies and projects. The agenda of the Forum is locally-controlled by a Planning Committee made up of representatives from throughout the watershed. A roster of Forum participants is provided in Table 1, located in Chapter X of this report.

The Upper Clear Creek Watershed Association, which mostly represents dischargers in Clear Creek and Gilpin Counties, is a formal organization and part of the Denver Regional Council of Governments' regional planning effort. The Upper Clear Creek Watershed Advisory Group was formed to provide technical input on EPA and CDPHE cleanup projects. These groups spearheaded many efforts to improve cooperation in the basin. As an example of the cooperative spirit, stakeholders developed a list of 47 proposed watershed projects in 1993. So far 26 of these projects have been completed. To highlight just a few, they include the McClelland tailings cleanup, stream restoration through Idaho Springs, a joint stream monitoring program, and the publication and adoption of a "best management practices" (BMP) manual. The Project 2000 list, a list of projects expected to be completed by the year 2000, has now been developed. (See Table 2.)

II. CLEAR CREEK AS A DRINKING WATER SOURCE

Background

The watershed approach has fostered a remarkable spirit of cooperation and the use of common sense in addressing issues of water *quality*. The area of water *quantity* and *supply*, however, is much more competitive. Water from the Clear Creek watershed has been put to many uses over the last 137 years. Historically, it has been used for mining, agriculture, drinking water supplies, and industry such as flour mills, breweries, and manufacturing. Today, it provides drinking water for nearly 350,000 people and recreational opportunities for rafters, kayakers, fishermen, and gold panners. Clear Creek serves industrial purposes such as breweries and electrical production. The demand for Clear Creek water makes it one of the most over-appropriated streams in Colorado.

Stream Flow Characteristics

The discharge of Clear Creek has traditionally been measured by the U.S. Geological Survey at the Golden stream gage. The average peak flow is 1,255 cubic feet per second (cfs) and the average low flow is 28 cfs. About 75 percent of the annual flow is from snow melt and occurs in May, June and July. During late summer and winter, certain segments of Clear Creek are essentially dry.

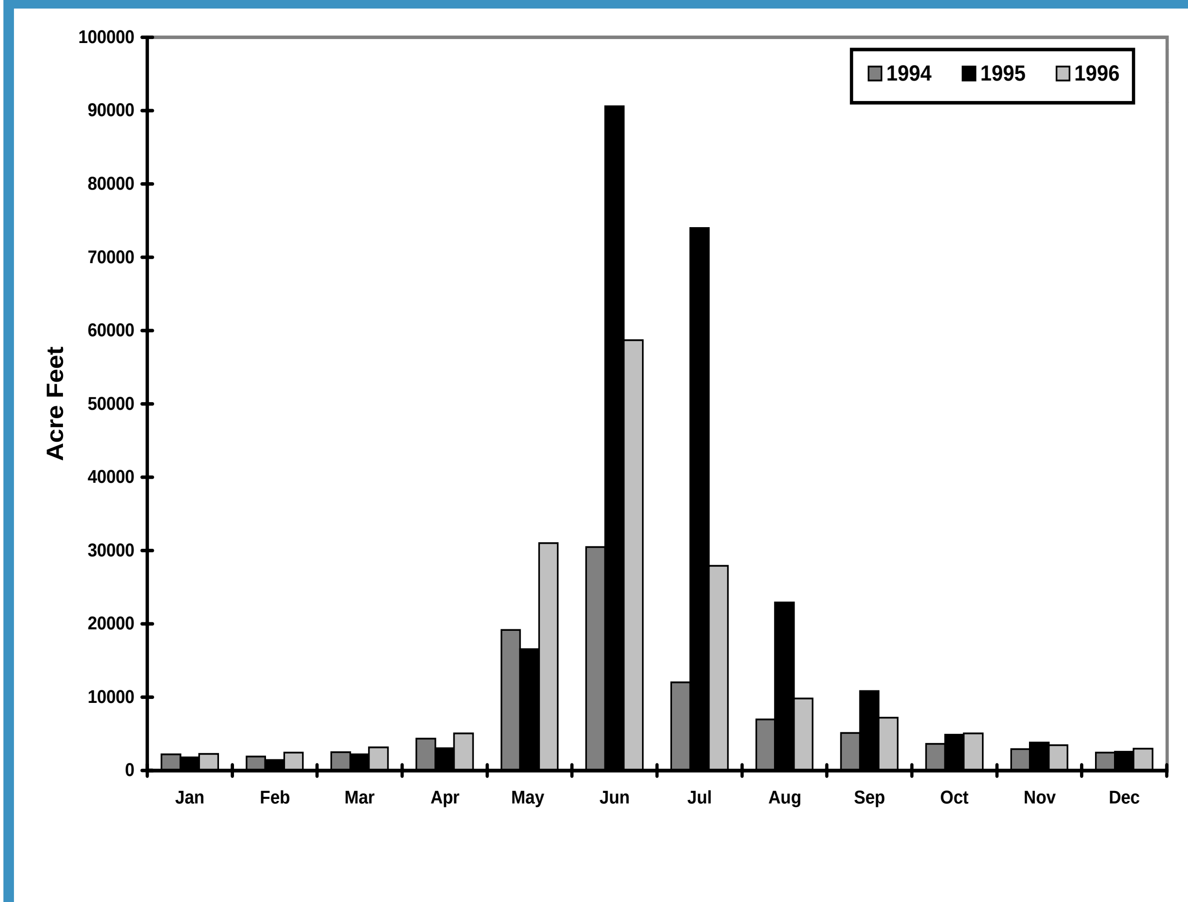
There are 18 stream flow gages on Clear Creek. Their locations are shown on Map 2 in Chapter X of this report. Funding for the operation of the gages comes through a successful "Adopt-a-Gage" program. (See Table 3 for a list of gage sponsors.)

CUBIC FOOT PER SECOND (CFS): *The rate of stream flow equal to one cubic foot (7.5 gallons) of water every second . One cfs flowing for one day results in a volume of water equal to about two acre-feet.*

ACRE-FOOT: *The volume of water required to cover one acre of land to a depth of one foot. An acre-foot is equal to about 325,825 gallons or the water required by two families of four for one year.*

Groundwater Characteristics

Groundwater is integral to the water quantity story of Clear Creek. In the headwaters portion of the watershed, groundwater accumulates in fractured rock and in alluvial deposits adjacent to Clear Creek. Metals from



CLEAR CREEK FLOW SUMMARY

This graph shows the total monthly flows at the Golden gaging station for 1994 through 1996. The spring of 1995 was a time of flooding and this is reflected in the June 1995 total flow which approached 91,000 acre feet.

natural and mining-related sources impact both groundwater and surface water as Clear Creek flows through the mineralized belt which crosses Clear Creek and Gilpin Counties. Extensive alluvial deposits of groundwater, as well as the deep aquifers of the Denver Basin, exist in the lower portion of the watershed.

GROUNDWATER: *Subsurface water which accumulates in underlying geologic formations as well as in fractured rock and alluvial (sand and gravel) deposits near stream beds. Groundwater and surface water are interconnected, in places readily flowing one to the other. In other places, this transfer of water may take more than 100 years. Areas of groundwater accumulation are called "aquifers" and can be tapped with wells for drinking water and other uses.*

Water Rights

The ability to use water from Clear Creek is determined by water rights. Water rights have a quantity and a priority date associated with them. There is generally adequate water in Clear Creek to satisfy all water rights during high flow. During low flow periods, when there is not enough water to satisfy all demands, the water users with the first or most senior water rights have first priority for water use.

Water rights are classified as direct flow water rights or storage rights. Direct flow rights generally run from April 1 through October 31 of any given year and involve taking water and using it immediately for activities such as irrigation. Storage rights, which generally run from October 31 through April 1, involve taking water and storing it in a reservoir for future use.

WATER RIGHTS: *The concept of Western water rights originated during the California gold rush. To keep peace among competing mining camps, a system was developed so that the miner who was the first to use the water had claim to that water. The second miner was next in line and so forth. This system was brought to Colorado during this state's mining boom and it became known as the Colorado Doctrine or the First-in-Time, First-in-Right Doctrine. This system of water rights became the law in 1876 when Colorado achieved statehood.*

In Colorado, a water right is a property right. The right can be sold or inherited. Water rights are generally measured in cfs or acre-feet. The current market rate for an acre-foot of high quality Clear Creek water with a senior water right is $8000 to $9000. The first water rights on Clear Creek were established in 1860.

HOW DOES A CALL WORK?: *When a senior water right is exercised, it is termed a "call"—for the simple reason that it is usually initiated with a telephone call to the water commissioner. Here's how the water commissioner works. Assume that water is being diverted to water rights holders with decrees dated 1860 and 1880. If someone with an 1870 decree puts in a call, the water commissioner will make sure that someone drives out to the field and physically shuts off the headgate of the 1880 water right holder and opens the headgate of the 1870 water right holder. Because there can be dozens of water rights holders and diversion structures on a stream, the call system can be quite complex.*

The seasonal pattern of water rights for Clear Creek tends to be distributed as follows:

During <u>late summer and early fall</u>—moderate flow—the controlling calls are from local water rights holders, e.g., those with 1860s and 1870s decrees such as the Church Ditch, Colorado Agricultural Ditch, and Farmers' High Line Canal which divert water to local communities and industry.

During <u>spring</u>—high flow—there can be calls from further down the South Platte River system because there is enough water to satisfy local senior water rights holders, e.g., those with 1860s decrees, as well as junior water rights holders, e.g., those with 1870s and 1880s decrees.

During <u>winter</u> —low flow—the calls on Clear Creek are controlled by storage decrees such as the Croke Canal, which diverts water to Standley Lake, and calls from the South Platte.

Table 4, provided in Chapter X of this report, shows the Clear Creek water rights and priority list for the lower basin.

In-stream Flow Rights

Generally the most junior and smallest water rights are for in-stream flows. In-stream flow is the amount of water needed to "preserve the natural environment [and aquatic life] to a reasonable degree." For the past 20 years this has been generally interpreted as the flow necessary to sustain cold water fisheries, such as trout. Currently, this focus is being broadened to include warm water fisheries, e.g., smallmouth bass, black bullhead, and channel catfish, as well as endangered species. An in-stream flow appropriation gives the Colorado Water Conservation Board a water right. Calls from senior water rights holders can still deplete water from segments with in-stream flow rights; however, a more junior water right holder cannot encroach upon in-stream flow appropriations.

In-stream flow appropriations for selected stream segments start with flow recommendations, based on field analysis, from the Colorado Division of Wildlife (CDOW). CDOW provides recommendations to the Conservation Board which evaluates them against various criteria. If the Conservation Board agrees with CDOW's recommendations, they forward them to Colorado District Court, generally referred to as Water Court, for a decree which establishes an in-stream flow appropriation.

Tables provided in Chapter X of this report document those segments in Clear Creek which have decreed in-stream flow appropriations (Table 5) and where CDOW has made in-stream flow recommendations (Table 6). Map 3 displays the decreed minimum in-stream flows for Clear Creek.

Clear Creek Water Usage

Nowhere is the issue of water use highlighted more dramatically than by the network of canals and ditches which take water from Clear Creek and transport it to the various lower basin users. Table 7, included in Chapter X, lists the ditches and their management companies and major shareholders. Water from Clear Creek is used for a variety of purposes: aquatic life, recreation, water supply and agriculture. It is used both in-basin and trans-basin.

In-basin water use consists of water taken from Clear Creek for use within the watershed. About 40 percent of Clear Creek's annual flow is used in-basin. Trans-basin use involves diverting water from Clear Creek and transporting it through canals to another watershed. About 40 percent of Clear Creek's annual flow is used outside of the basin. Whereas some of the water used in-basin returns to Clear Creek, none of the trans-basin water is returned to Clear Creek. About 20 percent of Clear Creek water flows through to the South Platte River due to calls or lack of storage on Clear Creek.

Water Storage Facilities

Because of the variance in high and low flows and the time of year when water is in greatest demand, dams and reservoirs have been built in the Clear Creek watershed to capture some of the spring runoff for use during drier months of the year. There are a number of water storage facilities in the watershed, as well as outside of the basin, which receive water from Clear Creek. These are listed in Table 8, included in Chapter X of this report.

TRANS-MOUNTAIN DIVERSIONS

There are several trans-mountain diversions which flow through the Clear Creek watershed:

Gumlick and Vasquez Tunnels: These tunnels are part of the City of Denver's water system. Water from the Williams Fork in Grand County comes into the Clear Creek watershed through the Gumlick Tunnel, formerly known as the Jones Pass tunnel, near the Henderson Mine. Water is immediately diverted from the Gumlick Tunnel out of the watershed through the Vasquez Tunnel. From there, the water takes a roundabout route through Vasquez Creek (in the Fraser River system), Moffat Tunnel, South Boulder Creek, and Ralston Creek (in the Clear Creek watershed), to Ralston Reservoir. Water from Ralston Reservoir is then transferred to the Moffat Plant in Lakewood for treatment and distribution.

Vidler Tunnel: The Vidler Tunnel is owned by Water Resources Company, Inc. The Vidler transports water from Dillon Reservoir into the Clear Creek watershed near Argentine Pass above Georgetown. From there it flows down Leavenworth Creek to South Clear Creek to the main stem of Clear Creek. Water is then diverted into the appropriate downstream canal depending on who has contracted to receive the water.

Berthoud Pass Ditch: The Berthoud Pass Ditch is owned by the City of Northglenn. It transports water from Current Creek (in the Fraser River system) to Hoop Creek (in the Clear Creek watershed). Water is then diverted downstream at the Church Ditch which leads to Standley Lake.

WATER SUPPLIERS

Dozens of businesses, industrial facilities, towns and cities rely on Clear Creek, or on groundwater aquifers in the watershed, for all or a portion of their water supply. Locations of some of these water supplies are shown on Map 4 in Chapter X. Major water users, from the top of the watershed down, who tap primarily surface water sources include:

--- Town of Silver Plume
--- Town of Georgetown
--- Town of Empire
--- City of Idaho Springs
--- City of Central
--- City of Black Hawk
--- City of Golden
--- Coors Brewing Company
--- City of Arvada
--- Consolidated Mutual Water Company (City of Wheat Ridge, etc.)
--- Public Service Company
--- City of Northglenn
--- City of Thornton
--- City of Westminster

Major water users, from the top of the watershed down, who tap groundwater sources include:

--- campgrounds in the Clear Creek Ranger District of the Arapaho & Roosevelt National Forest
--- facilities in Golden Gate State Park
--- St. Mary's Glacier Water & Sanitation District
--- Gilpin County Justice Center
--- trailer parks
--- campsites
--- restaurants
--- lodges
--- schools
--- private home owners

III. FISH AND OTHER AQUATIC LIFE IN CLEAR CREEK

Clear Creek is a very complex and dynamic ecosystem, composed of an interconnecting community of biological organisms and their habitats. The health of these organisms and their habitats is of concern in the Clear Creek watershed. The fish and their food sources are not healthy in some tributaries and in most areas of the main stem of Clear Creek.

CDOW has been studying the health of Clear Creek for many years. CDOW has eight established monitoring stations on Clear Creek from Georgetown to west of Golden. (See Map 5.) Using data collected at these stations, CDOW is documenting changes in the aquatic community of Clear Creek. In the late 1940's, CDOW began stocking trout in Clear Creek. Stocking efforts continue to this day.

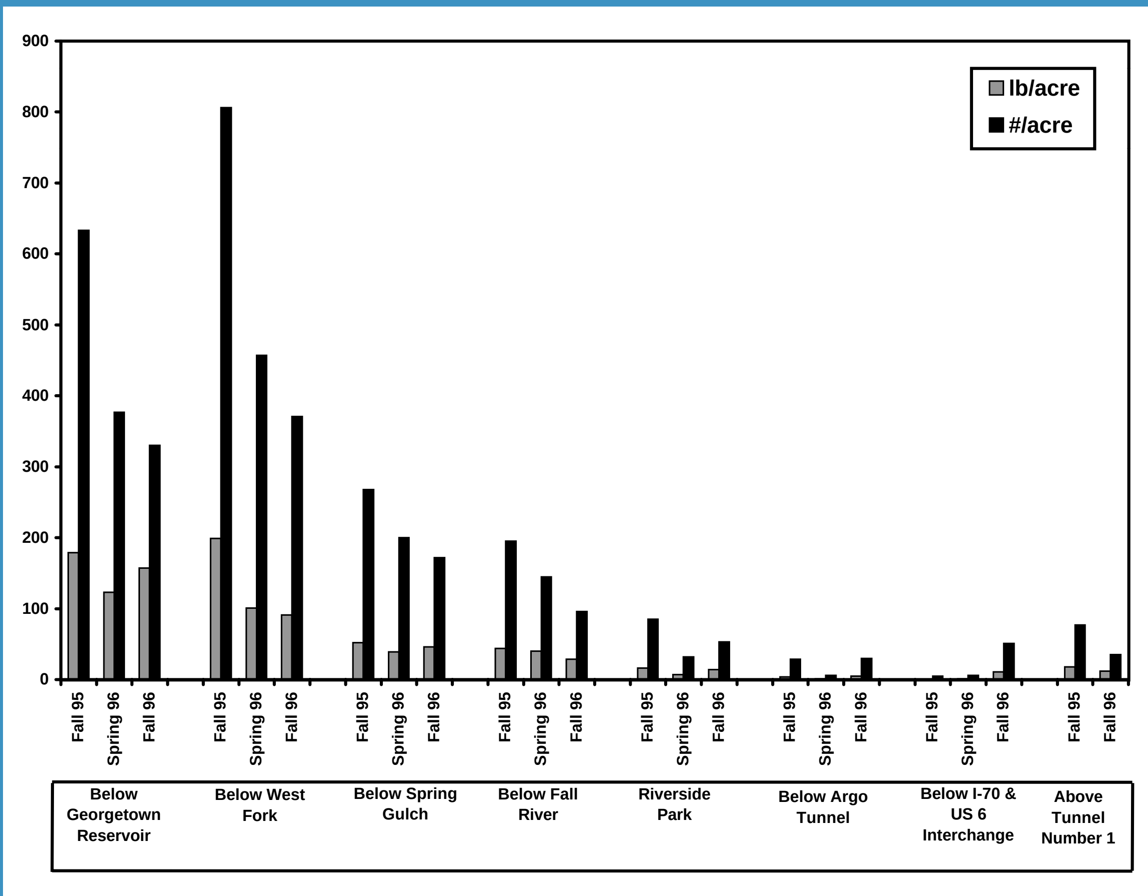
WHAT IS A MACROINVERTEBRATE?: *CDOW is not just interested in the types and numbers of fish in Clear Creek. CDOW, along with CDPHE and EPA, monitors what the fish eat — a group of aquatic species called macroinvertebrates. Macroinvertebrates are represented by various types of organisms including stoneflies, caddisflies, mayflies, true flies, beetles, leeches, and worms. Since macroinvertebrates are sensitive to certain environmental conditions, such as pollution in the water, they can be used to indicate the health of a river.*

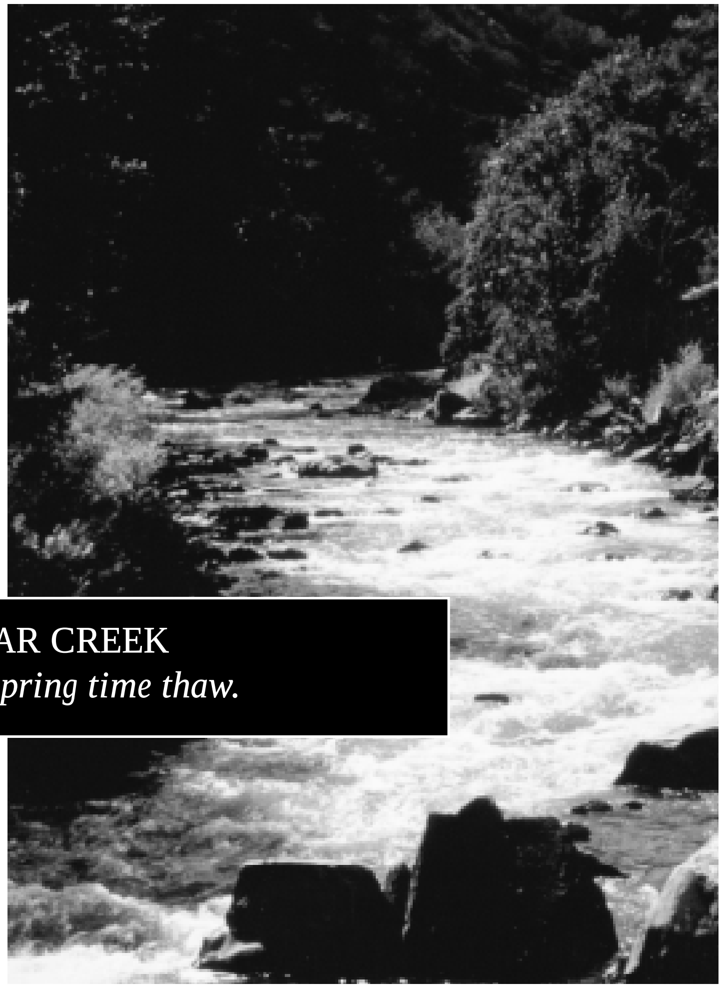
The trout species found by CDOW within the watershed include rainbow, brown, brook, and cutthroat trout. Brown trout are the dominant species in most Clear Creek stream reaches. The longnose sucker, a fish which is native to Clear Creek, is also found in the watershed. Rainbow trout are stocked by CDOW in several sections of the creek. The federally-protected, greenback cutthroat trout is found in some headwater areas of the watershed.

Results of the 1995 and 1996 sampling program indicate that metal contamination continues to impact the aquatic community of Clear Creek. The largest reduction in numbers of fish and macroinvertebrates occurs in the stream reach downstream of the Argo Tunnel. The aquatic community of Clear Creek from just downstream of the West Fork to Spring Gulch is considered by CDOW to be the best reference reach in the study area.

FISH IN CLEAR CREEK 1995 & 1996

This graph summarizes just a small portion of the fishery data collected on Clear Creek over the years by the Colorado Division of Wildlife. Fish were collected in the fall of 1995 and 1996, low-flow seasons, and also in the spring of 1996, during higher flow. During each monitoring event, two collection passes were made at each sampling site using an electro-fishing unit. Brown trout was the dominant species throughout the main stem of Clear Creek. The health of the fishery can be determined, in part, by the number of fish per acre of stream and also by their weight and age. The number of fish in Clear Creek shows a marked decline in the downstream direction. This is in part a result of the increasing levels of metals in the stream. Poor habitat is also a factor. The fish monitoring data will provide valuable baseline information as conditions in the river improve as a result of the many ongoing cleanups.





CLEAR CREEK
The spring time thaw.

FOR MORE INFORMATION:

Clear Creek Biological Monitoring Program, prepared by John Woodling, CDOW, January 1997.

Clear Creek Basin - The Effects of Mining on Water Quality and the Aquatic Ecosystem, prepared by CDOW, March 1991.

Clear Creek Phase II Remedial Investigation Report, prepared by Camp, Dresser, and McKee for the Colorado Department of Public Health and the Environment, September 21, 1990.

Chemical and Physical Assessment of North Clear Creek During July 1994, prepared by Water Science for the Environmental Protection Agency, May 1995.

Chemical, Physical, & Biological Assessment of Clear Creek and Selected Tributaries in the Clear Creek Basin During Fall 1995, prepared by Water Science for the Environmental Protection Agency, September 1996.

IV. LIMITING FACTORS

Nutrients

Nutrients

Phosphorus and nitrogen are essential nutrients for plant growth. Above certain levels, however, these nutrients lead to the growth of algae in lakes. This, in turn, may create unpleasant taste and odors in drinking water, promote the growth of nuisance weeds or floating scum, and reduce the oxygen level in the lakes. This process is called "eutrophication." Because of concerns about eutrophication, the users of Standley Lake are interested in reducing the amount of nutrients that come into the lake.

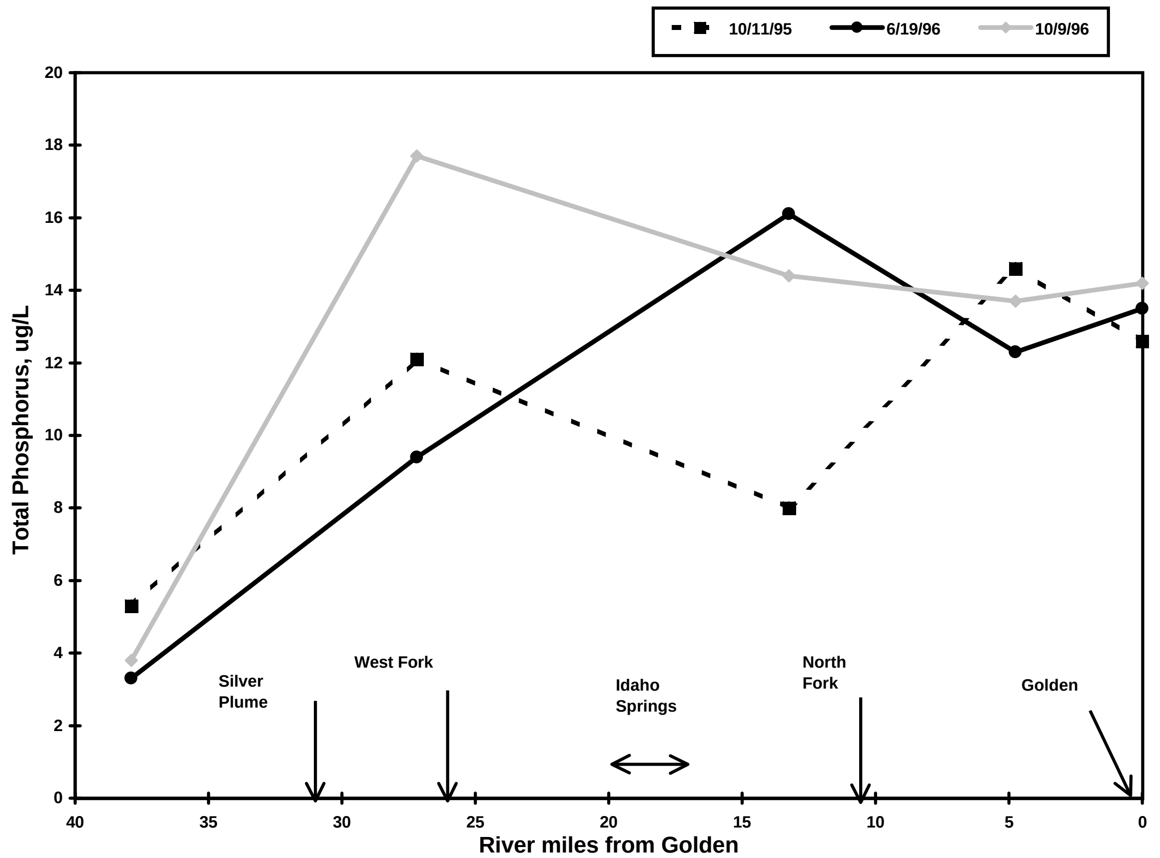
Over the last three years, Clear Creek watershed stakeholders have made a concerted effort to understand how much and where nutrients are entering Clear Creek and Standley Lake. More than 20 organizations have signed the Clear Creek Watershed Agreement which commits them to monitoring Clear Creek, Standley Lake, and the "Tributary Basin" which feeds into Standley Lake. The organizations are also committed to reducing the amount of nutrients entering the watershed through such means as additional treatment at wastewater treatment plants, controlling septic systems, requiring BMPs at construction sites, in-lake treatment, and public education about the use of phosphate detergents.

The 1996 Annual Report of the Clear Creek Watershed Agreement summarizes data from three years of nutrient monitoring in Clear Creek, Standley Lake, and the Tributary Basin. The data were collected through a monitoring program conducted by the Upper Clear Creek Watershed Association and the Standley Lake Cities. Each time the organizations monitor Clear Creek, they provide water to EPA for metal analysis as an additional component of the monitoring program. The monitoring began in 1994 and continues today. Map 2 shows the location of the monitoring stations. Additional nutrient data are shown later in this report in Chapter VII, the chapter focusing on geographic areas of the Clear Creek watershed.

The Standley Lake Cities have developed a watershed management model to assist them in predicting sources and quantities of nutrients entering Standley Lake. In addition, the Denver Regional Council of Governments has developed a water quality model of Clear Creek to better understand how nutrients behave in the river.

PHOSPHORUS IN THE MAIN STEM OF CLEAR CREEK

This graph shows some of the data available on phosphorus in Clear Creek. The data set is from the joint monitoring program of the Upper Clear Creek Watershed Association and the Standley Lake Cities. The graph shows total phosphorus concentrations in the main stem of Clear Creek from the top of the watershed to the City of Golden. Data are shown for two low flow times, October 1995 and 1996, and for one high flow time, June 1996. There is no water quality standard for phosphorus in Clear Creek. (ug/L - micrograms per liter)



STANDLEY LAKE
Recreation at its best.

SOURCES OF NUTRIENTS: *There are many possible sources of nutrients in the Clear Creek basin. Much of the basin is covered by forested land which is rich in nutrients. The nutrients are carried into the river during rainstorms or with melting snow, especially in areas disturbed by road cuts, logging, or other activities. Agricultural land that is fertilized and irrigated is a source of nutrients, as are the fertilized green lawns of our homes. Municipal wastewater treatment plants are also sources of nutrients. Over the last three years, the waste/water treatment plant operators in the Clear Creek watershed have been improving their systems so that the amount of nutrients released into Clear Creek is reduced. There are many households in the Clear Creek watershed that are not connected to a municipal sewer system but instead use septic systems, outhouses, or other on-site facilities collectively known as individual sewage disposal systems. The counties within the watershed are working to ensure that individual sewage disposal systems are installed correctly and working properly.*

FOR MORE INFORMATION:

Clear Creek Watershed Agreement -1996 Annual Report, 1996.

Upper Clear Creek Watershed QUAL2E Model, February 1994, prepared for the Upper Clear Creek Watershed Association by the Denver Regional Council of Governments.

Clear Creek/Standley Lake Watershed Management Study, April 1994, prepared by Camp, Dresser, and McKee for the Cities of Northglenn, Thornton, and Westminster.

IV. LIMITING FACTORS (CONT.)

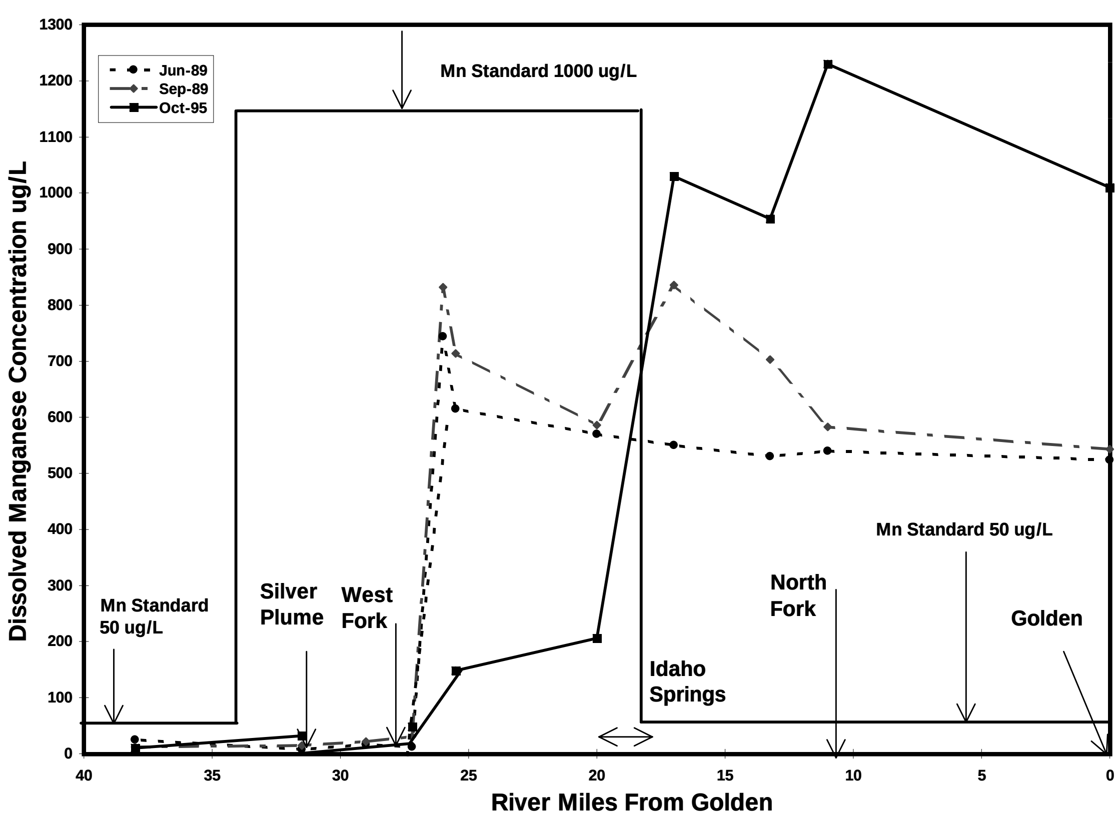
Metals

The discovery of gold in the Clear Creek watershed in May 1859 set off a gold rush. Soon, mining fever spread throughout the area. Portions of the Clear Creek watershed still experience the impacts of this historic mining activity. Mine tunnels, built to empty the working mines of water and to allow for hauling of ore, continue to drain the historic mines. Often, the water is acidic and carries a host of metals with it. Mine dumps — piles of waste rock discarded as the miners dug to reach the gold veins — and mine tailings — material left over from milling of the gold ore — dot the hillsides of the Clear Creek watershed. Like the water draining from the old mine tunnels, the mine dumps and tailings piles are often acidic, and contain high levels of metals which can seep into Clear Creek or be carried into it by stormwater or snow melt. Metals can also be introduced into Clear Creek by road cuts or other development in mineralized zones.

Many of the metals, especially zinc, copper, and cadmium, are toxic to fish and other aquatic life of Clear Creek. Generally, people are less sensitive to metals than fish. Manganese, however, has been a concern of the municipalities that use Clear Creek for their drinking water. This is because the metal is present at high levels within Clear Creek, and it is expensive and difficult to remove manganese from the water. At high levels, manganese can be a health concern for people drinking the water and, at intermediate levels, manganese can stain laundry and cause water to taste poorly.

CDPHE and EPA have studied the impacts of metals on Clear Creek and have pinpointed the mine tunnels, mine dumps, and tailings piles that are causing the greatest harm to the river. Graphs provided in this section illustrate some of this information. Efforts are under way by CDPHE and EPA to clean up the major sources of metals. These efforts and those of other organizations, such as the Colorado Division of Minerals and Geology, are discussed later in this report.

Metals data have been gathered since 1985 through the EPA and CDPHE Superfund programs discussed in Chapter V, and since 1994 through the joint Upper Clear Creek Watershed Association, Standley Lake Cities, and EPA monitoring program. EPA and CDPHE have used these data to build a water quality model to aid in the understanding of how metals move and where they end up (the fate and transport) in the Clear Creek system. The model can also be used to predict the results of cleanup actions that take place in the watershed.

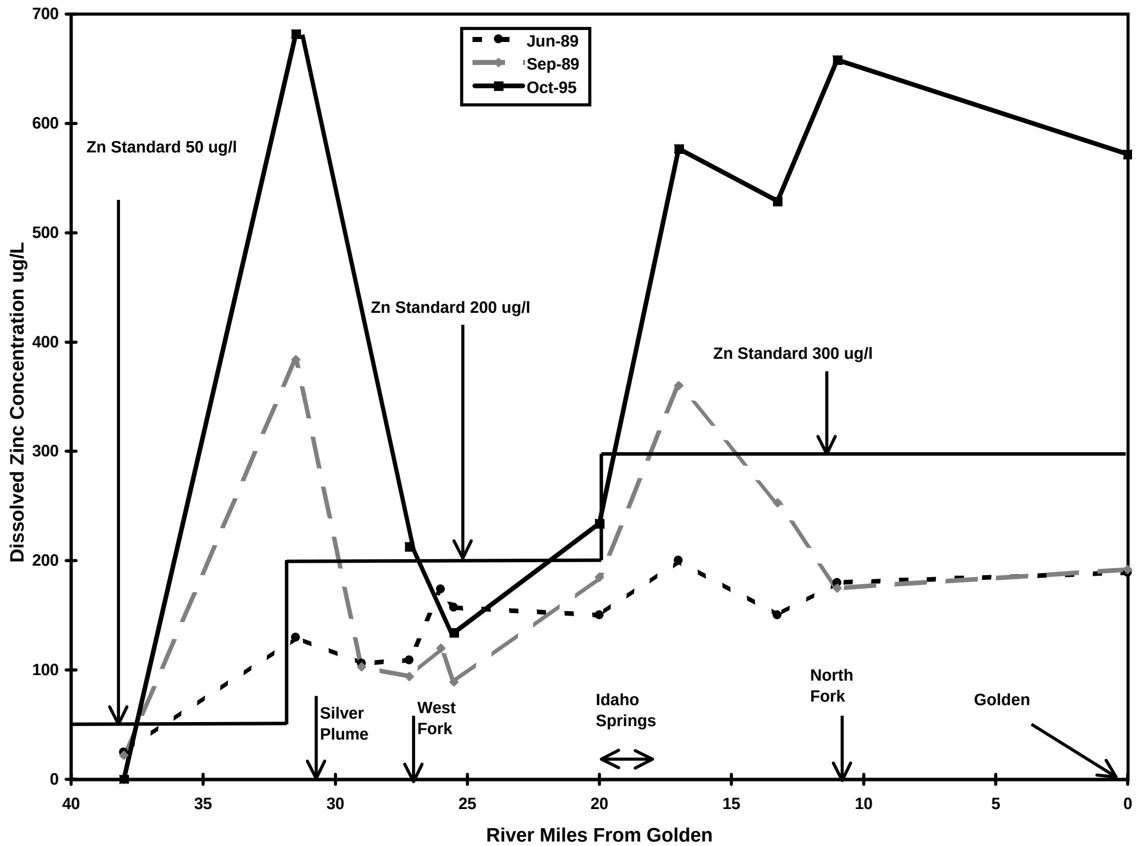


DISSOLVED MANGANESE IN THE MAIN STEM OF CLEAR CREEK

Manganese levels in the main stem of Clear Creek generally increase from the top of the watershed to the City of Golden. The major sources of manganese in the main stem are the West Fork of Clear Creek and the Argo Tunnel. The amount of manganese reaching the main stem of Clear Creek from the West Fork has dropped due to efforts by Cyprus-Amax to reduce the amount of manganese coming from the Henderson and historic Urad mines. The state stream standard for manganese is usually exceeded downstream of the Argo mine tunnel. Manganese levels instream are expected to drop in December 1997 when a treatment plant at the Argo Tunnel begins operation. Data are from EPA and CDPHE Superfund studies.

DISSOLVED ZINC IN THE MAIN STEM OF CLEAR CREEK

The amount of zinc in Clear Creek generally increases as the river water moves downstream from the headwaters to the City of Golden. The major point sources of zinc are the Burleigh Tunnel in Silver Plume and the Argo Tunnel in Idaho Springs. Zinc levels in-stream through Idaho Springs are expected to drop once the Argo Tunnel treatment plant begins operating in December 1997. The West and North Forks of Clear Creek also contribute zinc to the main stem. A significant source of zinc is in Idaho Springs, where mineralized groundwater from Virginia Canyon enters Clear Creek. State stream standards for zinc increase downstream in a step-wise fashion. The standards are generally exceeded through the extent of the river except for the very upper reaches. Data are from EPA and CDPHE Superfund studies.



DISSOLVED MANGANESE IN THE WEST FORK OF CLEAR CREEK

Historically, there have been very high levels of manganese in the West Fork of Clear Creek. The primary source of the manganese has been the Henderson and historic Urad mines located on Woods Creek. Cyprus-Amax began treating water from the mines in the 1990's using a relatively low-technology, in lake treatment approach. This graph shows the resultant improvements in the water quality of the West Fork. Even further improvements are expected in the West Fork now that the company has built a water treatment plant for the mine water. Data are from EPA and CDPHE Superfund studies.